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Assessment of the Mandibular Buccal Shelf for Safe Miniscrew Insertion in Teenagers and Adults: A Cone-Beam Computed Tomography Study

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Objectives This study assessed the mandibular buccal shelf (MBS) for safe miniscrews insertion in teenagers and adults.
Methods Cone-beam computed tomography (CBCT) images of 30 teenagers and 30 adults were used to measure bone width and cortical bone thickness. Measurements were made at four sites buccal to the distobuccal cusp of mandibular 1st molar (D6), and mesiobuccal cusp (MB7), an area at the center of the bifurcation (Mid7), and distobuccal cusp (DB7) of mandibular second molar. Bone width was measured at four distances (4, 6, 8, and 10 mm) from the (CEJ). ANOVA was used for statistical analysis.
Results The MBS was significantly different within each age group and in different age groups, tooth sites, distances from the CEJ, and cortical bone thicknesses (P<0.001). A significant difference was detected in bone width between the two age groups in D6 at all distances from the CEJ, MB7 and Mid7 at 4 mm and 6 mm, and DB7 at 4 mm from the CEJ (P<0.05). Cortical bone thickness was significantly different between the two groups at MB7, Mid7, and DB7 (P<0.05).
Conclusion All distances from the CEJ at DB7 offered adequate bone width for safe miniscrew implantation. Mid7 showed suitable bone width at all distances from the CEJ in teenagers. In adults, miniscrews should be implanted at 6 mm from the CEJ. Miniscrews should be inserted in at least 8 mm distance from the CEJ at MB7. D6 is unsafe for miniscrew insertion in both groups at all distances from the CEJ.
Keywords Cone-Beam Computed Tomography; Orthodontics; Orthodontic Anchorage Procedures; Mandible

Introduction

Anchorage control is the most crucial factor for successful fixed orthodontic treatment of dental and skeletal malocclusions.[1, 2] Miniscrew is the most commonly used temporary anchorage device for orthodontic treatment because of its advantages such as easy insertion and removal, being inexpensive, small size enabling its placement between the roots, easy positioning in several intraoral sites, placement with minimal trauma, allowing immediate loading after insertion (as there is only fibrous integration) and therefore reducing the treatment time, and minimal or no need for patient cooperation.[3] However, they have disadvantages and some risks during placement, orthodontic loading, and at the time of removal, such as nerve damage, perforation of the maxillary sinus, roots resorption, soft tissue complications, and the possibility of breakage during insertion or removal.[4] Orthodontic miniscrews can provide absolute anchorage which is a desirable form of anchorage for ideal treatment results, and can improve orthodontic mechanics.[5, 6] Presence of adequate bone at the placement site is the most important factor for placement of orthodontic miniscrews.[7]

The stability of miniscrews includes primary stability achieved immediately after insertion, and secondary stability due to osseointegration.[8] On the other hand, primary stability is a significant factor in successful long-term placement of miniscrews, which depends on mechanical retention instead of osseointegration.[9, 10] Miniscrews have good acceptance by patients and approximately low failure rate.[11, 12] Many factors affect the miniscrew stability; the primary factor is the quantity and quality of cortical bone, while cancellous bone has a little effect on the stability of miniscrews. Moreover, poor oral hygiene, smoking, mucosal type at the placement site (keratinized mucosa vs. non-keratinized mucosa), the time required for healing, surgical placement technique, the amount and direction of applied force, miniscrew placement torque, contact with the roots, the properties of the insertion site, and the design of miniscrew (type, length, diameter, thread design, shape, surface characteristics, and biocompatible material) can all affect the stability of miniscrews.[9, 13, 14]

Miniscrews can be positioned in various anatomical sites depending on orthodontic treatment's indication and biomechanics.[5] These sites include the palate, the palatal aspect of the maxillary alveolar process, the maxillary infra-zygomatic crest, the mandibular retromolar area, and the maxillary and mandibular buccal cortical plates.[5, 15] Currently, miniscrews are placed in the mandibular buccal shelf area (MBS) located bilaterally in the posterior part of the mandible, buccal to the roots of the first and second molars, and anterior to the oblique line of the mandibular ramus.[15] This area has the thickest cortical bone in the mandible; its slope is flattened from the anterior towards the posterior area, resulting in more comfortable placement of miniscrews in this region. The miniscrews are inserted extra-radicularly in this area; thus, they will not interfere with distalization of teeth.[16] There are considerable indications for using the MBS as a miniscrew placement site, especially in camouflage correction of mild to moderate skeletal class III malocclusion to correct the anterior crossbite.[16]

Previously, miniscrews were used to be placed blindly or by using two-dimensional radiographs. The two-dimensional radiographs (periapical, occlusal, panoramic, and cephalometric radiography) used in dentistry do not provide adequate information about the interradicular space, root morphology, thickness of cortical bone, and position of the inferior alveolar nerve.[17, 18] Three-dimensional computed tomography is not widely used in dentistry. It produces images with artifacts, is costly, requires ample space, requires a long time for scanning, and has high patient radiation dose.[17, 19] With the development of three-dimensional cone-beam computed tomography (CBCT), it is now widely used in dentistry for evaluation of dentofacial structures and finding an appropriate site for safe placement of miniscrews. It has a less complicated device and lower patient radiation dose, is less expensive, produces images with minor artefacts and reasonable resolution, and helps in assessment of the quality and quantity of the maxillary and mandibular alveolar bone.[17, 20]

This study aimed to find safe placement sites for orthodontic miniscrew placement in MBS of the molar region and assess the possible differences in miniscrew placement sites between the teenagers and adults using CBCT.

Methods and Materials

This retrospective study obtained ethical approval from Shahid Beheshti University, School of Dentistry, Tehran, Iran (IR.SBMU.DRC.REC.1399.068). The sample comprised of 60 CBCT images in two groups: the first group included the CBCT scans of teenagers between 12-17 years (n=30), and the second group included the CBCT scans of adult patients between 18-24 years (n=30). Each patient was given a code; Y1-Y30 to teenagers and A1-A30 to adults to facilitate analysis and comparison. The CBCT images were retrieved from the archives of the Radiology Department of Dental School, Shahid Beheshti University of Medical Sciences from 2015 to 2020; the search took about one month. All CBCT scans had been taken with NewTom VGI CBCT scanner (QR, Verona, Italy), with the exposure settings of 3.3-10 mA, 110 kVp, and minimum voxel size of 150 µm by postgraduate students of oral and maxillofacial radiology. Each CBCT scan was converted to DICOM format. The CBCT images had been taken for purposes not related to this study. The inclusion criteria were optimal-quality CBCT scans visualizing the MBS area with good resolution, no missing or extracted teeth except for mandibular third molars, presence of completely erupted mandibular second molars, no genetic syndromes or craniofacial abnormalities, absence of periapical lesions or periradicular pathologies (with endodontic or periodontal origin), no history of previous orthognathic surgical treatment, no horizontal bone loss [the normal alveolar crest had to be nearly 1.5-2 mm apical to the cementoenamel junction (CEJ); its shape had to be flat, smooth and parallel to the line connecting the adjacent CEJs] and no vertical bone loss (absence of infrabony pockets) at the examined site. The data were processed in NNT Viewer version 8 software.

After correct orientation, which was done by importing the file to NNT Viewer software, the area extending from the distobuccal cusp of the mandibular first molar to the distobuccal cusp of the mandibular second molar was divided into 0.3 mm slices. The thickness of cortical bone and the bone width of the mandibular buccal shelf area were measured at four distances from the CEJ. These areas were buccal to the distobuccal cusp of the mandibular first molar (D6); buccal to the mesiobuccal cusp (MB7), an area at the center of the bifurcation (Mid7), and distobuccal cusp (DB7) of the mandibular second molar. The cortical bone thickness was measured from the midpoint of the bony ledge buccal to the mandibular first and second molars (buccal shelf), parallel to the buccal root surface contour of the first or second molar (Figure 1). The buccal shelf bone width was the total amount of bone available in the buccolingual direction from the most buccal point of the alveolar bone to the mandibular molars' root. At first, the CEJ was defined for each tested location (Figure 2). Next, the measurements were made at 4, 6, 8, and 10 mm in apical direction from the CEJ (Figure 3). All measurements were repeated after one month by the same investigator to assess the intra-rater reliability.

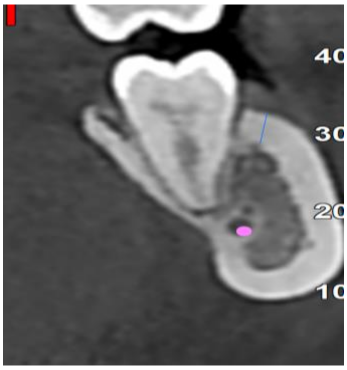

Figure 1- Measuring the cortical bone thickness

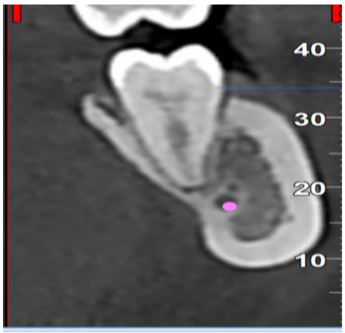

Figure 2- Detection of CEJ

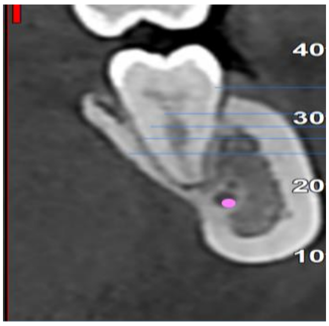

Figure 3- Drawing lines at 4, 6, 8, and 10 mm from the CEJ

In order to detect at least 1.5 mm difference in bone width between the teenagers and adults considering α=0.05 and β=0.2, the minimum sample size for each group (teenagers and adults) was calculated to be 30 samples (standard deviation=1.97) according to a study by Elshebiny et al (7). SPSS version 21.0 (IBM Corp., Armonk, NY, USA), was used for statistical analyses. The intraclass correlation coefficient (ICC) was used to assess the intra-rater reliability between the two measurement time points, and also paired samples t-test was applied to evaluate the mean difference between the two measurement time points. Descriptive statistics (mean, standard deviation) were used to report the measured variables. ANOVA with two within-factor and one between-factor variable was used to assess the effects of patients' age group (teenagers and adults), tooth site (D6, MB7, Mid7, and DB7), location (4 mm, 6 mm, 8 mm, and 10 mm) and cortical bone thickness. Comparisons were made to detect the difference in bone width and cortical bone thickness between the groups (teenagers and adults), at each tooth site and location.

Results

For Intra-rater reliability and absolute agreement assessment, 2-way mixed-effects ICC model was used. According to Table 1, the ICC for assessing intra-rater reliability in all positions was acceptable and above 0.90. The results of paired t-test revealed no significant difference between the two measurement time points (P>0.6).

Table 1- Descriptive results

		Mean	SD	95% CI for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
At 4_D6_t2	Teenagers	1.60	0.45	1.43	1.77	0.90	2.70
	Adults	1.35	0.26	1.25	1.45	0.90	1.80
At 6_D6_t2	Teenagers	2.44	0.69	2.18	2.70	1.50	4.50
	Adults	2.06	0.44	1.90	2.22	1.20	3.00
At 8_D6_t2	Teenagers	3.51	0.88	3.18	3.84	1.80	6.30
	Adults	3.03	0.74	2.76	3.30	1.80	4.80
At 10_D6_t2	Teenagers	4.55	1.04	4.16	4.94	2.70	7.50
	Adults	3.95	0.90	3.61	4.29	2.40	6.00
C_DB6_t2	Teenagers	1.81	0.35	1.68	1.94	1.30	2.40
	Adults	1.86	0.39	1.71	2.01	1.30	2.80
At 4_MB7_t2	Teenagers	3.71	1.17	3.27	4.15	2.10	6.00
	Adults	3.07	0.80	2.77	3.37	1.50	4.80
At 6_MB7_t2	Teenagers	4.95	1.08	4.55	5.35	3.00	7.20
	Adults	4.39	0.99	4.02	4.76	2.40	6.00
At 8_MB7_t2	Teenagers	5.93	0.96	5.57	6.29	4.20	8.10
	Adults	5.58	1.08	5.17	5.99	3.30	7.20
At10_MB7_t2	Teenagers	6.76	0.91	6.42	7.10	4.80	8.40
	Adults	6.56	1.04	6.17	6.95	4.50	8.40
C_MB7_t2	Teenagers	2.74	0.34	2.61	2.87	2.20	3.50
	Adults	3.11	0.33	2.99	3.24	2.30	3.60
At 4_Mid7_t2	Teenagers	5.32	1.04	4.93	5.71	2.70	7.20
	Adults	4.44	1.02	4.06	4.82	2.40	6.30
At 6_Mid7_t2	Teenagers	6.16	1.03	5.78	6.54	3.60	8.70
	Adults	5.61	0.89	5.28	5.94	3.90	6.90
At 8_Mid7_t2	Teenagers	6.66	1.00	6.29	7.03	4.20	9.00
	Adults	6.35	0.91	6.01	6.69	4.50	7.80
At10_Mid7_t2	Teenagers	7.13	0.98	6.77	7.49	4.80	9.30
	Adults	6.97	1.03	6.59	7.35	4.80	9.00
C_Mid7_t2	Teenagers	3.04	0.36	2.90	3.18	2.50	3.90
	Adults	3.45	0.30	3.34	3.56	2.80	3.90
At4_DB7_t2	Teenagers	6.15	1.04	5.76	6.54	3.60	7.80
	Adults	5.52	1.10	5.11	5.93	3.30	7.50
At6_DB7_t2	Teenagers	6.86	0.88	6.53	7.19	5.10	8.40
	Adults	6.59	0.92	6.25	6.93	4.50	8.70
At8_DB7_t2	Teenagers	7.44	0.81	7.14	7.74	6.00	9.30
	Adults	7.33	0.94	6.98	7.68	5.40	9.60
At10_DB7_t2	Teenagers	7.98	0.86	7.66	8.30	6.30	10.50
	Adults	7.95	1.05	7.56	8.34	6.00	9.90
C_DB7_t2	Teenagers	3.52	0.41	3.37	3.67	2.60	4.20
	Adults	3.75	0.25	3.66	3.84	3.20	4.20

The bone width and cortical bone thickness measurements are presented in Table 1. As shown, the bone thickness in the MBS area increased as moved distally from the distal root of the mandibular first molar to the distal root of the mandibular second molar and apically from the CEJ. In other words, the buccal area relative to the distobuccal cusp of the mandibular first molar (D6) had thinner bone width at 4 mm apical to the CEJ in both teenager and adult groups (teenagers: 1.60±0.45 mm, adults: 1.35±0.26 mm). Thicker bone width was noted buccally to the distobuccal cusp of the mandibular second molar (DB7) at 10 mm apical to the CEJ in both groups (teenagers: 7.98±0.86 mm, adults: 7.95±1.05 mm). Also, the cortical bone thickness increased as moved distally; the area buccal to the distobuccal cusp of the mandibular first molar

(D6) had the lowest cortical bone thickness in teenager and adult groups (teenagers: 1.81±0.35 mm, adults: 1.86±0.39 mm). In contrast, the maximum cortical bone thickness was noted buccal to the distobuccal cusp of the mandibular second molar (DB7) in both groups (teenagers: 3.52±0.41 mm, adults: 3.75±0.25 mm).

Significant interactions were found between the tooth site (D6, MB7, Mid7 and DB7), distance from the CEJ (4 mm, 6 mm, 8mm and 10 mm), and cortical bone thickness (P<0.001). Also, significant interactions were found between age group (teenagers and adults), tooth site, distance from the CEJ, and cortical bone thickness (P<0.001). To compare the effect of age, due to significant interaction effects, separate comparisons were made for each combination of tooth and distance from the CEJ. The details are presented in Table 2. The results showed that the teenagers had a significantly higher mean bone width than adults (P<0.05) in the area buccal to the distobuccal cusp (D6) of the mandibular first molar at all distances from the CEJ (4 mm, 6 mm, 8 mm, and 10 mm), in areas buccal to the mesiobuccal cusp (MB7) and mid-furcation (Mid7) of the mandibular second molar at 4 mm and 6 mm apical to the CEJ, and the area buccal to the distobuccal cusp of the mandibular second molar (DB7) only at 4 mm apical to the CEJ. Also, the cortical bone thickness showed a significant difference (P<0.05) at MB7, Mid7, and DB7.

Table 2 – Descriptive analysis of bone thickness in both groups at different points

Tooth	Distance from CEJ	(I) Group	(J) Group	Mean Difference (I-J)	SE	p-value
Distal L6	4 mm	Teenagers	Adults	0.25*	0.09	0.010
	6 mm	Teenagers	Adults	0.38*	0.15	0.014
	8 mm	Teenagers	Adults	0.48*	0.21	0.026
	10 mm	Teenagers	Adults	0.60*	0.25	0.020
	Cortical	Teenagers	Adults	-0.04	0.10	0.628
Mesial L7	4 mm	Teenagers	Adults	0.64*	0.26	0.016
	6 mm	Teenagers	Adults	0.56*	0.27	0.041
	8 mm	Teenagers	Adults	0.35	0.26	0.190
	10 mm	Teenagers	Adults	0.20	0.25	0.432
	Cortical	Teenagers	Adults	-0.37*	0.09	0.000
Middle L7	4 mm	Teenagers	Adults	0.88*	0.27	0.002
	6 mm	Teenagers	Adults	0.55*	0.25	0.031
	8 mm	Teenagers	Adults	0.31	0.25	0.215
	10 mm	Teenagers	Adults	0.16	0.26	0.539
	Cortical	Teenagers	Adults	-0.40*	0.09	0.000
Distal L7	4 mm	Teenagers	Adults	0.63*	0.28	0.027
	6 mm	Teenagers	Adults	0.27	0.23	0.252
	8 mm	Teenagers	Adults	0.11	0.27	0.628
	10 mm	Teenagers	Adults	0.03	0.25	0.904
	Cortical	Teenagers	Adults	-0.23*	0.09	0.011

Discussion

In recent years, the MBS area has been used as an implantation site for miniscrews; this area is located bilaterally in the posterior part of the mandible buccal to the first and second molars' roots and anterior to the oblique line of the mandibular ramus. Moreover, the thickest cortical bone of the mandible is present in this area. This area has sufficient amount of bone in the buccal direction so that miniscrews can be inserted extra-radicularly in the MBS parallel to the roots of molar teeth. This insertion paradigm has the advantage of preventing potential contact between roots and miniscrews during the movement of teeth along the alveolar process. However, this implantation mode decreases the risk of connection between the tooth roots and miniscrews during insertion, which is one of the significant factors that causes failure of miniscrews.[15, 16, 21, 22]

Chang et al,[23] in their study concluded that miniscrews should be implanted in the MBS area to obtain optimal anchorage during distalization of mandibular teeth. They found that when stainless steel miniscrews with 2 mm diameter are inserted as parallel as possible to the mandibular first and second molars, they have about 5 mm of bone contact after implantation. There was no difference in the success rate of miniscrews implanted in movable mucosa or attached gingiva. The reason for miniscrew placement in the moveable mucosa is that many patients have small width of attached gingiva buccal to the molar teeth; however, the most important factor in successful maintenance of miniscrews in this area may be the elevated position of the miniscrew head, which facilitates oral hygiene control and prevents peri-screw inflammation. On the other hand, they discovered that miniscrews placed in the MBS have a low failure rate of around 7%; they found lower success rate of miniscrews implanted in the left side in younger adolescent patients. A small portion of patients (1.9%) in their study had implantation failure in both the right and left sides.

Various studies used CBCT to evaluate the quality and quantity of bone to assess miniscrew implantation sites and the structures at risk in these areas. Moreover, the critical factors for implantation of orthodontic miniscrews are the cortical bone thickness and bone width. [5, 7, 13, 24]

This retrospective study assessed the MBS for safe implantation of miniscrews in teenager and adult patients. We used CBCT images to evaluate the cortical bone thickness and bone width in an Iranian population sample at four sites (DB6, MB7, Mid7, DB7), and at four vertical distances (4, 6, 8, and 10 mm) at each site apical to the CEJ.

In the present study, we found that the MBS area had significant differences (P<0.001) based on tooth site (D6, MB7, Mid7, and DB7), distance from the CEJ (4 mm, 6 mm, 8 mm, and 10 mm), and cortical bone thickness, as the bone width increased by moving in the apical and distal direction in both groups. In other words, thinner bone width was noted at D6, 4 mm apical to the CEJ; while thicker bone width was found in DB7 at 10 mm apical to the CEJ (Table 1). Escobar-Correa et al,[25] Kolge et al,[26] Elshebiny et al,[7] and Nucera et al.[15] obtained similar results. Also, the cortical bone thickness had the same pattern as bone width and increased towards the distal in both groups (Table 1). The same result was obtained by Elshebiny et al,[7] and Baumgaertel and Hans.[5]

On the other hand, we found that the MBS had a significant difference (P<0.001) based on age groups (teenagers and adults), tooth site (D6, MB7, Mid7, and DB7), distance from the CEJ (4 mm, 6 mm, 8 mm, and 10 mm), and cortical bone thickness as the bone width was lower in the adult group than in younger patients (Table 1). Gandhi et al.[27] found the same result as growing (young) patients had larger buccal bone width than adult patients; they explained the reason to be the molar roots, which were used as reference point for measuring the bone width and their different stage of eruption in growing patients. We also found that the cortical bone thickness was thinner in the younger group than in adults (Table 1). Farnsworth et al.[28] reported results in accordance with ours. They found that the cortical bone was thinner in adolescents than in adult patients; this result is due to improved functional capacity in adults (maximum bite force, size of masticatory muscles, and muscle activity).

Nucera et al.[15] mentioned that the bone width in the MBS should be at least 5 mm to allow safe implantation of miniscrews with 1.6 mm diameter. However, Chang et al.[23] considered the same 5 mm bone width for placement of stainless steel miniscrews with 2 mm diameter. Our study considered a 5-mm buccal bone width at the MBS as a cut-off value to determine the safest sites for miniscrew implantation as an assumption for the maximum miniscrew width that might be used in this site, which is 2 mm and with a 1.5-mm clearance from tooth roots; cortical bone plates should also be present.

Descriptive analysis (Table 1) showed that the MBS area buccal to the distobuccal cusp of the mandibular first molar had the thinnest bone width; it also indicated that this area had insufficient bone width for implantation of miniscrews in both young and adult groups at all vertical distances from the CEJ.

In the area buccal to the mesiobuccal cusp of the mandibular second molar, descriptive analysis (Table 1) showed that the location at 4 mm and 6 mm apical to the CEJ had inadequate or insufficient amount of bone width for insertion of miniscrews. Simultaneously, adequate amount of bone width for safe implantation of miniscrews was noted at 8 mm and 10 mm vertical to the CEJ in both group

However, the buccal midpoint of the mandibular second molar showed that at 4 mm vertical distance from the CEJ, the younger patients had sufficient amount of bone width for safe placement of miniscrews. In contrast, adults showed insufficient bone width at the same vertical distance from the CEJ for safe miniscrew insertion. On the other hand, other vertical distances (6 mm, 8 mm, and 10 mm) had sufficient bone width in both groups for safe implantation of miniscrews.

The wide range of standard deviation values and significant differences between the minimum and maximum bone width values in the previously mentioned areas, which had insufficient buccal bone width, were noted in descriptive analyses. We suggest taking CBCT from the first molar area in cases where miniscrew is needed to be placed in this area due to high versatility in bone width. The area buccal to the distobuccal cusp of the mandibular second molar had the thickest bone width in the MBS area. As shown in descriptive analysis (Table 1), this location in both groups and at all apical distances from the CEJ had sufficient bone thickness for safe placement of miniscrews.

Motoyoshi et al.[29] discussed that miniscrews should be inserted in an area with at least 1 mm cortical bone thickness to obtain reasonable primary stability and high 6-month success rate. All sites in our study showed mean values of cortical bone thickness more than 1 mm, indicating that the MBS area has a reasonable success rate.

Comparing the age groups in different combinations of tooth site and distance from the CEJ (Table 2), it was clear that the young group had significantly greater bone width than adults in the area buccal to the distobuccal cusp (D6) of the mandibular first molar at all distances from the CEJ (4 mm, 6 mm, 8 mm, and 10 mm). Gandhi et al. [27] reported results in line with our findings.

On the other hand, in the areas buccal to the mesiobuccal cusp (MB7) and midpoint (Mid7) of mandibular second molar, comparison of the age groups in different combinations of tooth site and distance from the CEJ (Table 2) showed that the younger patients had significantly higher bone width at 4 mm and 6 mm apical to the CEJ. However, other distances from the CEJ (8 mm and 10 mm) showed insignificant difference in bone width between the teenagers and adults. However, bone width in the area buccal to the distobuccal cusp (DB7) of the mandibular second molar showed a significant difference only at 4 mm apical to the CEJ. Other distances (6 mm, 8 mm, and 10 mm) showed insignificant differences. We could not explain this variability because of the limited available data in the literature. However, a possible explanation may be the close relation of the masseter muscle insertion site to the mandibular second molar as it occurs below the external oblique ridge of the ramus. [30] Forces from the function of the masseter muscle can explain the increased bone width at the external oblique ridge level while the upper and lower levels show lower bone width. [28]

When comparing the age groups in different combinations of tooth site and distance from the CEJ (Table 2), the cortical bone thickness showed a significant difference at MB7, Mid7, and DB7 while D6 did not show a statistical difference. Farnsworth et al. [28] demonstrated no significant difference in the cortical bone thickness between teenager and adult groups in the mandibular area distal to the first molar. This difference could be due to the difference in age of the two groups in our study. Also, it could be due to the measurement method as they assessed the interradicular area between the first and second molars, and the measurement was made at the horizontal reference line at 4 mm apical to the alveolar bone crest.

Our study evaluated the safe implantation site in teenager and adult patients based only on bone measurements without considering the effect of soft tissue type, which was a limitation of this study because miniscrew stability may be affected by the type of soft tissue around it. Future studies with larger sample size are required to assess the effect of gender, growth pattern, and implantation in the right or left sides on the measurements. Further studies are needed to assess the insertion depth and its relationship with the inferior alveolar nerve.

Conclusion

In the MBS area, the bone width was greater in younger patients. The buccal area relative to the distobuccal cusp of the mandibular second molar had thicker bone width, providing an appropriate site for miniscrew implantation in both teenager and adult patients at all vertical distances from the CEJ. The area buccal to the midpoint of the mandibular second molar showed sufficient bone width at all vertical distances from the CEJ in teenagers. In contrast, in the adult group, the site at 4 mm apical to the CEJ was unsuitable for miniscrew implantation and miniscrews should be inserted 6 mm apical to the CEJ. This was the only difference between the two groups regarding the safe placement sites. In the area buccal to the mesiobuccal cusp of the mandibular second molar, miniscrews should be inserted at least at 8 mm distance from the CEJ in both groups. In teenagers and adults, and at all apical distances from the CEJ, the area buccal to the distobuccal cusp of the mandibular first molar showed insufficient bone width for miniscrew insertion.

Conflict of Interest

No Conflict of Interest Declared ■

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